HARECES measurements on hexagonal boron nitride

Scientific Achievement

We probed the anisotropic electronic structure of hexagonal boron nitride (h-BN) using high angular resolution electron channeling electron spectroscopy (HARECES) technique. By studying both the core loss and low loss regions of an EEL spectrum we are able to derive complementary information of the electronic structure and dielectric response of this material. We investigated both core-loss and low-loss regions of the EEL spectra recorded at different scattering vectors on a single crystal of h-BN, and we interpret the different excitations by comparison with theoretical models. Our results significantly improve the older work on this material and we demonstrate that HARECES is the most powerful technique to perform momentum-resolved EELS.

Significance

h-BN is an insulating, anisotropic material structurally analogous to semimetallic graphite. Recently, the interest in h-BN has increased due to the synthesis of boron nitride nanotubes (BNNTs), which can be seen as a h-BN sheet rolled up into a cylinder. An improved knowledge of the physical properties of h-BN is necessary to understand the related properties in BNNTs. In this way the use of EELS in a transmission electron microscope is a powerful technique for investigating the electronic properties of a material at the nanometer scale. Our HARECES measurements provide very useful information about the electronic structure of h-BN. Although our work is concentrating initially on understanding the observed changes in the electronic structure of small single crystal specimens, we will be applying these interpretations to results obtained from boron nitride nanotubes.

Performers

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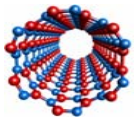
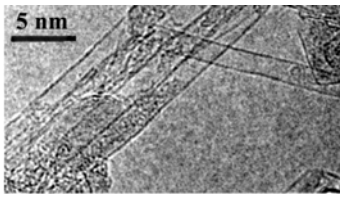
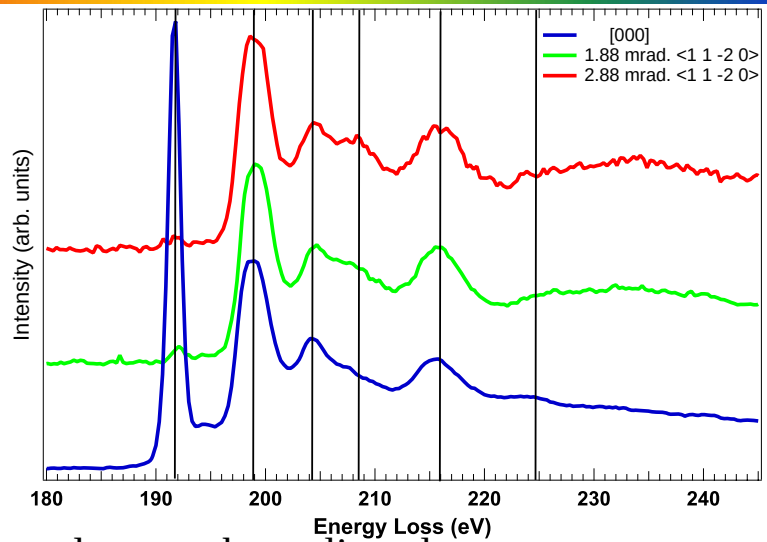




High resolution TEM image of boron nitride nanotubes



Boron K edge in hexagonal boron nitride

We showed that high angular resolution electron channeling electron spectroscopy (HARECES) technique is between the different existent techniques to perform momentum resolved EELS, the most powerful to probe the anisotropic electronic structure of a layered material, such as hexagonal boron nitride (h-BN) at the nanometric scale.

These results are the first EELS measurements showing the complete disappearance of the first peak of the boron and nitrogen K edges under q perpendicular to c condition. This confirms that the origin of these peaks is the transition of a 1s electron to the B-2*pz* and the N-2*pz* orbitals, in the boron and nitrogen edges respectively.

Initially our work is concentrating on understanding the observed changes in the electronic structure of small single crystal specimens. Upon completion, we will apply these interpretations to results obtained from boron nitride nanotubes.

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